

3.4 HEALTH AND SAFETY

This section describes existing health and safety hazards at the project site and identifies potential health and safety risks from project construction and operation, including the risk of fire or explosion, potential for release of hazardous materials, ice throw, tower collapse, blade throw, shadow-flicker, dust hazards, vandalism, electric and magnetic fields, and electric shock hazards. Mitigation measures are identified for potential impacts. The analysis in this section is primarily based on information provided by the Applicant in the ASC (Sagebrush Power Partners LLC 2003a, Sections 2.9, 4.1, and 7.2). Where additional information has been used to evaluate the potential impacts associated with the proposal, that information has been referenced.

3.4.1 Affected Environment

The proposed project would be constructed on between approximately 93 to 118 acres (depending on the project scenario) of a larger project area that covers approximately 3.5 miles (east-west) by 5 miles (north-south) in a hilly, rural landscape of rangeland. The project site is traversed by multiple sets of electrical transmission lines—one set of PSE lines running east to west and five sets of Bonneville lines also running east to west across the project site.

There are few existing hazards at the project site. Fire is the primary health and safety risk at the site. The project site is generally arid rangeland with a predominant groundcover of grasses and sagebrush. The highest expected fire risks are grass fires during the hot, dry summer season. Under existing conditions, fires could be started by lightning strike or by human activities such as careless disposal of lighted cigarettes or dry vegetation contacting hot exhaust catalytic converters under vehicles. However, lightning strikes at the project site are rare and human use at and around the site is limited.

3.4.2 Impacts of Proposed Action

This section describes the potential direct health and safety impacts in the project area from development of the KVVPP. Direct impacts could be associated with construction, operations, and decommissioning of any of the proposed project elements, including the wind turbines and meteorological towers, existing and new gravel access roads, additional power lines, and the proposed O&M facility and substations. Impacts associated with or attributable to specific project elements are discussed where applicable. Health and safety risks during construction include potential fire or explosion and release of hazardous materials to the environment. Health and safety risks during project operation include these risks as well as others specific to wind turbine generators such as ice throw, tower collapse, blade throw, and shadow-flicker. Indirect impacts are not anticipated because the project is not expected to substantially induce regional growth to the extent that it would result in significant offsite health and safety risks. Table 3.4-1 summarizes potential health and safety risks identified under the three project scenarios.

Table 3.4-1: Summary of Potential Health and Safety Risks

	82 Turbines/3 MW (Lower End Scenario)	121 Turbines/1.5 MW (Middle Scenario)	150 Turbines/1.3 MW (Upper End Scenario)
Construction Impacts			
Risk of fire or explosion	231 total acres disturbed; Up to 164 blasts for turbine foundation construction	311 total acres disturbed; Up to 242 blasts for turbine foundation construction	371 total acres disturbed; Up to 300 blasts for foundation construction
Release of hazardous materials at construction sites	Same as middle scenario	25,000 gallons fuel (diesel and gasoline) for mobile construction equipment; hydraulic fuel	Same as middle scenario
Operations and Maintenance Impacts			
Risk of fire or explosion	82 turbines and pad mounted transformers, up to 2 substations and 4 meteorological towers	121 turbines and pad mounted transformers, up to 2 substations and 4 meteorological towers	150 turbines and pad mounted transformers, up 2 substations and 4 meteorological towers
Release of hazardous materials	Same volume and potential for release per turbine as middle scenario, but slightly lower probability of release due to lesser number of turbines	50 gallons/turbine glycol- water mix	Same volume and potential for release per turbine as middle scenario, but slightly greater probability of release due to higher number of turbines
		85 gallons/turbine of hydraulic oil	
		105 gallons/turbine of lubricating oil	
	500 gallons/pad mounted transformer of mineral oil; 41,000 total gallons	500 gallons/pad mounted transformer of mineral oil; 60,500 total gallons	500 gallons/pad mounted transformer of mineral oil; 75,000 total gallons
	Same as middle scenario	12,000 gallons/substation transformer of mineral oil; up to 48,000 gallons	Same as middle scenario
Ice thrown from rotating blades	82 turbines; 3 blades/turbine; individual blade length = approx. 150 feet	121 turbines; 3 blades/turbine; individual blade length = approx. 115 feet	150 turbines; 3 blades/turbine; individual blade length = approx. 100 feet
Tower collapse and blade fragments thrown from rotating blades	82 turbines; 3 blades/turbine; individual blade length = approx. 150 feet	121 turbines; 3 blades/turbine; individual blade length = approx. 115 feet	150 turbines; 3 blades/turbine; individual blade length = approx. 100 feet
Shadow-flicker effects (related to number/size of rotor blades and rotor speed) ¹	122.2 shadow-flicker hours/year at Receptor M. Genson (worst-case receptor)	93.6 shadow-flicker hours/year at Receptor M. Genson (worst-case receptor)	Shadow-flicker not modeled under this scenario.
Potential for dust hazards	Same as middle scenario	Negligible	Same as middle scenario
Vandalism	Same as middle scenario	Negligible	Same as middle scenario
Electric and magnetic field hazards	Same as middle scenario	Negligible health and safety effects	Same as middle scenario
Electrical shock hazards	Same as middle scenario	Negligible with proper design	Same as middle scenario

Table 3.4-1: Continued

	82 Turbines/3 MW (Lower End Scenario)	121 Turbines/1.5 MW (Middle Scenario)	150 Turbines/1.3 MW (Upper End Scenario)
Decommissioning Impacts			
Risk of fire or explosion	Similar in nature but less than construction impacts	Similar in nature but less than construction impacts	Similar in nature but less than construction impacts
Release of hazardous materials	Similar to construction impacts	Similar to construction impacts	Similar to construction impacts

Source: Sagebrush Power Partners LLC 2003a, f.

1 The blades would turn at about 10 to 23 rpm. Generally, larger wind turbine generators have slower-rotating blades, but the specific rpm values depend on aerodynamic design and vary across machines.

Construction Impacts

Risk of Fire or Explosion

There is a risk of unintentional or accidental fire or explosion during project construction. The highest expected fire risks are grass fires during the hot, dry summer season. Natural risk of unintentional fire or explosion, such as from a lightning strike would be the same regardless of project scenario. The potential fire risk from human activities would be greatest for the upper end scenario because this scenario would involve the greatest amount of activities such as ground disturbance (approximately 317 acres) and welding (on a per turbine basis) that could lead to accidental fire or explosion.

The Applicant's proposed Fire and Explosion Risk Mitigation Plan, presented in Table 3.4-3 in Section 3.4.4, Mitigation Measures, lists sources of potential fire and explosion during project construction along with measures to mitigate these risks. Implementation of these programs would ensure that project construction would not pose a substantial fire or explosion risk to human health and safety or the environment. Impacts associated with provision of adequate fire protection services to the site during project construction are discussed further in Section 3.13, Public Services and Utilities.

Due to the rocky conditions on site, blasting would be required to excavate foundations for the proposed wind turbines. If solid rock is encountered close to the ground surface while installing the underground cables, blasting may also be performed to excavate the cable trench to the required depth. It is anticipated that most wind turbine foundations would require one to two blasts each. Potential blasting impacts would be greatest under the upper end scenario because it would require constructing the largest number of turbines (150) over the longest period of time (approximately three months). Implementing safety measures proposed by the Applicant as part of its Fire and Explosion Risk Mitigation Plan during blasting activities would minimize risks associated with use of explosives.

Releases or Potential Releases of Hazardous Materials to the Environment

Fuel and lubricating oils from construction vehicles and equipment are potential sources of hazardous materials that could accidentally leak or be spilled during project construction.

However, this type of leak should not create a risk to health and safety or the environment because of the limited quantities of the materials involved. Diesel fuel is the primary potentially hazardous material that would be used in any significant quantity during project construction. Project construction would require the use of diesel fuel for operating construction equipment and vehicles. Estimated fuel consumption during construction would be approximately 25,000 gallons (diesel and gasoline) for mobile construction equipment, construction vehicles, and generators for the three project scenarios.

Mineral oil used to fill substation transformers is another potential source of hazardous materials that could accidentally be spilled during project construction. The project includes up to two substations, each with one or two substation transformers. Because they are delivered without oil in the tank, they would need to be filled with mineral oil onsite. As part of the commissioning process of the main transformers(s), they would be filled and tested. Each substation transformer would contain up to 12,000 gallons of mineral oil. The risk of an accidental spill of mineral oil at the substation construction sites would be low given the design features built into the project (see Section 3.4.4).

There is also a potential for an accidental release of hydraulic fluid or lubricating oils from construction equipment. However, lubricating oils and hydraulic fluids used during construction would mostly be contained in the vehicles and equipment for which they are used. Small quantities of lubricating oils may also be stored in appropriate containers at the construction staging area located at the site of the O&M facility. Implementation of appropriate spill prevention and control measures would ensure that the risk of an accidental release of hazardous materials remains low throughout construction (see Section 3.4.4).

Operations and Maintenance Impacts

Risk of Fire or Explosion

There is a risk of unintentional or accidental fire or explosion during project operations and maintenance. The risk of accidental fires from human activities such as cigarette smoking and use of vehicles off established roadways would be expected to be greatest under the upper end scenario due to the larger number of project employees (see Section 3.7, Socioeconomics, for further discussion of project employment). For mechanical fires, this impact would also be expected to be greatest under the upper end project scenario, which would operate the largest number of turbines (150). Impacts associated with provision of adequate fire protection services to the site during project operations and maintenance is discussed further in Section 3.13, Public Services and Utilities.

Lightning-induced fires are rare in the project area. As shown in the flash density map below (Figure 3.4-1), the Kittitas Valley and interior Washington in general, is not a highly lightning prone area. Furthermore, the wind turbine generators and other mechanical equipment at the substation and meteorological towers would be equipped with specially engineered lightning protection systems that would minimize the risk of lightning-induced fire during project operations (see Section 3.4.4).

Figure 3.4-1

As is the case with complex machines, there is some potential for fire caused by mechanical malfunction inside the wind turbine generators and at other project facilities. Implementation of proposed design measures for specific facilities and equipment and operational procedures would ensure that the risk of mechanical fire in project facilities would not pose a risk to health and safety or the environment (see Section 3.4.4).

The majority of the proposed electrical collection system would be buried underground, although a small portion (about 2 miles) would be constructed as overhead cables. There should be no risk of explosion. However, a brush fire could occur in the rare event that a conductor on a portion of the overhead cable parted and one end of the energized wire fell to the ground. Under this circumstance, fire-fighting capabilities of local fire districts would be called upon according to pre-arranged agreements to respond to the situation (see Section 3.13, Public Services and Utilities). Compliance with the project's Fire Protection and Prevention Plan would ensure that the risk of fire or explosion at the project facilities would not pose a risk to health and safety or the environment (see Section 3.4.4).

Releases or Potential Releases of Hazardous Materials to the Environment

Project operations would not result in the generation of regulated quantities of hazardous wastes. Because no fuel is burned to power the wind turbine generators, there would be no spent fuel, ash, sludge or other process wastes generated. Project operations would not require the use or storage of significant quantities of fuel or other materials that could cause a spill or other accidental release. Potential impacts associated with specific project facilities are described in more detail below.

Wind Turbine Generators

Periodic changing of lubricating oils and hydraulic fluids used in the individual wind turbine generators would result in the generation of small quantities of hazardous waste. These waste fluids would be generated in small quantities because they need to be changed only infrequently and the changing of these fluids is not done all at once, but rather on an individual turbine by turbine basis. The estimated amounts of lubricating oils, hydraulic fluids, and mineral oils required for project operations are presented in Table 3.4-1; the total amount would be slightly larger and smaller under the upper and lower end scenarios, respectively, due to differences in the overall number of turbines. This potential impact would be greatest under the upper end scenario, which would operate the largest number of turbines (150) and require the largest amount of oils and fluids during project operations—7,500 gallons of glycol-water mix, 12,750 gallons of hydraulic oil, and 15,750 gallons of lubricating oil. Based on the limited quantities of fluids contained in the wind turbine generators (50 gallons/turbine glycol-water mix, 85 gallons/turbine hydraulic oil, and 105 gallons/turbine lubricating oil) and the leak detection and containment systems engineered into their design (see Section 3.4.4), the potential for an accidental spill from wind turbine malfunction is low.

Electrical Collection System

Power from the turbines would be fed through a breaker panel at the turbine base inside the tower and would be interconnected to a pad-mounted step-up transformer, which step the voltage up to 34.5 kV. The pad-mounted transformers would contain mineral oil that acts as a coolant. Each pad-mounted transformer would contain up to 500 gallons of mineral oil. This potential impact would be greatest under the upper end scenario, which would operate the largest number of turbines (150) and therefore require a total of 75,000 gallons of mineral oil for project operations. Based on the leak detection and containment systems engineered into their design (see Section 3.4.4), the potential for an accidental spill from malfunction or breach of the pad-mounted transformers is low.

Substations and Interconnection Facilities

The project would be electrically connected to the power grid at a substation(s) that would be equipped with either one or two transformers. Each substation transformer would contain up to 12,000 gallons of mineral oil for cooling. Substation transformer requirements would be the same under the three project scenarios. Mineral oil used to fill substation transformers is a potential source of hazardous materials that could accidentally be spilled during project operations. The substation transformers would have a specifically designed containment system to ensure that any accidental fluid leak does not result in discharge to the environment (see Section 3.4.4).

Operations and Maintenance Facility

Waste fluids would be stored for short periods of time during project operations at the O&M facility. Measures incorporated into the design of the O&M facility would ensure that the risk of accidental spill or release of hazardous materials at the facility would be low and would not be a risk to health and safety or the environment.

Risk of Ice Throw from Turbine Blades

While more than 55,000 wind turbine generators have been installed worldwide, there has been no reported injury from ice thrown from wind turbines. Under icing conditions, all exposed parts of the wind turbine are liable to ice build-up. However, it has been observed that a moving turbine rotor is liable to accrete significantly heavier quantities of ice than stationary components. There are several mechanisms of ice accretion on structures. The most important of these, for wind turbines, is rime icing which occurs when the structure is at a sub-zero temperature and is subject to incident flow with significant velocity and liquid water content. The precise deposition mechanism is the subject of ongoing experimental and theoretical research (Morgan et al. 1998).

Ice throws occur as stationary turbine blades begin to rotate. Any ice shed prior to blade rotation would fall directly below the blade. Blades with ice build up turn slowly (only a few revolutions per minute) because the blade airfoil has been compromised by the ice, and the blades are unable to pick up any speed until the ice is shed. Reported data on ice throws at other projects indicate

that ice fragments were found on the ground from 50 to 328 feet from turbines (<33 to 197 feet blade diameter) and were in the range of 0.2 to 2.2 pounds in mass (Morgan et al. 1998).

Studies of long-term weather data for the area by the Applicant's consulting meteorologist indicate that icing conditions occur on average 3 to 5 days per year (Sagebrush Power Partners LLC 2003c, Exhibit 6). This is categorized as a "moderate icing" risk (1 to 5 days of icing per year) according to the Wind Energy in Cold Climates (WECO) study commissioned by the European Union's Environment Directorate (WECO n.d.). In contrast, "light icing risk" is less than 1 day icing per year and "heavy icing risk" is 5 to 25 days per year.

Therefore, based on the results of the Morgan et al 1998 study, potential public health and safety risks caused by ice falling off rotating blades could occur within 50 to 328 feet of an operating turbine tower. Minimum setbacks incorporated into the proposed project layout would reduce the safety risks associated with ice throw and other safety and nuisance concerns (see Section 3.4.4, Mitigation Measures).

Risk of Turbine Tower Collapse

During scoping for this EIS, concern for potential collapse of wind turbine towers was raised. This potential impact would be greatest under the upper end scenario, which would contain the greatest number of turbines (150). Curt Maloy of Worldlink Insurance in Palm Springs, California was contacted by the Applicant to gain comparative information regarding the types and degree of risk associated with wind power projects. He stated that his company (Worldlink) insures more than 12,000 turbines comprising more than 3,400 MW of capacity and that he personally has 15 years of experience with the wind industry. According to the Applicant, he stated that he was not aware of any tubular wind tower structure collapsing (Sagebrush Power Partners LLC 2003c). Review of Internet sites on the topic of wind power risks revealed photographic evidence of wind tower collapse in Europe (Danish Society of Windmill Neighbours 2003; MAIWAG 2003). However, the specific conditions and circumstances supporting this photographic evidence is uncertain. Minimum setbacks incorporated into the proposed project layout would reduce the safety risks associated with tower collapse and other safety and nuisance concerns (see Section 3.4.4, Mitigation Measures).

Risk of Turbine Blade Throw

Concern was raised by the public regarding the risk of blade throw (defined as blade fragments thrown from a rotating machine). The number and size of blades operating at the project site would vary for each project scenario. For example, as described above, under the lower end scenario, 82 turbines would be constructed and each turbine would support an approximate 150-foot diameter 3-blade rotor. Under the upper end scenario, 150 turbines would be constructed but each turbine would support an approximate 100-foot diameter 3-blade rotor (see Table 3.4-1).

According to the Applicant, international experience to date has indicated that there are low risks associated with components falling from towers, including blade throw. Furthermore, risks have been continually reduced as turbine technology has improved (Sagebrush Power Partners LLC 2003c). Review of Internet sites on the topic of wind power risks revealed photographic evidence

of wind tower parts such as blades detaching or failing (Country Guardian 2003). Blades were reported broken off on two occasions in 1995 at a facility in Tarifa, Spain (Windpower Monthly 1995), and in 1996, several cases of blade failures were documented in Germany (Country Guardian 2003). However, the specific conditions and circumstances supporting this photographic evidence and these reported cases of blade failure are uncertain. Minimum setbacks incorporated into the proposed project layout and compliance with engineering design and manufacturing safety standards would reduce safety risks associated with blade throw and other safety and nuisance concerns (see Section 3.4.4, Mitigation Measures).

Shadow-Flicker Effects

Shadow-flicker caused by wind turbines is defined as alternating changes in light intensity when the moving turbine blades cast shadows on the ground and objects (including windows at residences). Shadow-flicker is not caused by viewing the sun through rotating wind turbine blades or moving (i.e., driving) through the shadows of a wind farm, nor by sunlight being reflected from the turbine blades. Shadow-flicker can occur in project area homes if the turbine is located near a home and is in a position where the blades interfere with very low-angle sunlight. The most typical effects are the visibility of a pulsating shadow in the rooms of the residence facing the wind turbines and subject to the shadow-flicker. Such locations are typically called shadow-flicker receptors. Visual obstacles such as terrain, trees, or buildings between the wind turbine and a potential shadow-flicker receptor significantly reduce or eliminate shadow-flicker effects.

Shadow-flicker frequency is related to the rotor speed and number of blades on the rotor, which can be translated into a “blade pass frequency” measured in alternations per second, or hertz (Hz).

Two types of concerns have been raised regarding shadow-flicker effects: (1) they can cause epileptic seizures, and (2) that they can be an annoyance to local residences.

The Epilepsy Foundation has stated that frequencies below 10 Hz are not likely to trigger epilepsy seizures (Sagebrush Power Partners LLC 2003c), and current wind turbine technology would not produce frequencies greater than 10 Hz. As identified in Table 3.4-1, the project proposes to construct three-bladed wind turbines. The diameter of the circle swept by the blades would range from approximately 200 to 300 feet under the upper and lower end scenarios, respectively (that is, each blade would be approximately 100 to 150 feet long). The blades would turn at about 10 to 23 rpm. Generally, larger wind turbine generators have slower-rotating blades, but the specific rpm values depend on aerodynamic design and would vary across machines. Initial modeling (models run during April and June 2003) results were based on the NEG-Micon wind turbine model with a 235-foot rotor diameter and a nominal rotor speed of 17.3 rpm which translates to a blade pass frequency of 0.87 Hz (less than 1 alternation per second). This is significantly lower than 10 Hz threshold cited by the Epilepsy Foundation. To identify the level of annoyance effects to nearby receptor residences in the project area, shadow-flicker modeling was conducted by the Applicant between April and July 2003 (Sagebrush Power Partners LLC 2003c). The receptors (houses) that were selected for this analysis are those

that represent the potential worst-case scenarios. Based on their locations relative to the proposed turbines, these are the receptors where the greatest shadow-flicker impacts are expected.

The shadow-flicker model used for this analysis is produced by EMD of Denmark and is part of the WindPro modeling software package. The model requires the following inputs:

- Turbine locations
- Shadow-flicker receptor locations
- USGS 1:24,000 topographic map
- USGS DEM (height contours)
- Rotor diameter
- Hub height
- Joint wind speed and direction distribution
- Hours of sunshine (monthly averages)

The model calculates the shadow-flicker time for either a) each receptor, b) everywhere (defined squares), or both (a and b). A receptor is defined as a window at a residence. Azimuth of windows has been estimated for each residence (East, West or 90, 180, 270 degrees from the nearby access road) and the default window size is assumed to be 1-by-1 meter. The sun's path is calculated from the turbine location and the cast shadow derived over the day. Then the run-time for the turbine is derived from wind data (speed and direction measurements collected on site and compared with long-term data available from the Ellensburg Airport to make sure it is representative of long-term conditions). When the turbines are not operating (such as when the wind speed is too low) there is no shadow-flicker. The analysis also included obtaining the number of sunny days from NOAA weather maps that indicate the mean sunshine percentage in the area of the project. Shadow-flicker occurs only on days with sunshine and not on cloudy days.

When the wind direction is perpendicular to the direction of the wind turbine (as seen from the receptor) then the shadow-flicker time is reduced because the cast shadow is narrow, whereas when the wind direction is in line with the direction of the turbine (as seen from the receptor), then the full rotor plane shadow needs to pass the receptor. Cloudiness is also considered in the model (no direct sun means no shadow). Output from the model includes the following information:

- Turbine locations and elevations
- Calculated shadow-flicker time at selected receptors
- Tabulated and plotted time of day with shadow-flicker at selected receptors
- Listing of turbines causing shadow-flicker at each selected receptor
- Map showing turbine locations, selected shadow-flicker receptors, and line contours indicating projected shadow-flicker time (hours per year).

As indicated above, initial modeling (models run during April and June 2003) results were based on the NEG-Micon wind turbine model with a 235-foot rotor diameter and a nominal rotor speed of 17.3 rpm, which translates to a blade pass frequency of 0.87 Hz (less than 1 alternation per second).

The results of the initial shadow-flicker models raised the question of how shadow-flicker effects may vary under the lower end and middle scenarios for “worst-case” receptors. Therefore, the Applicant prepared an additional set of shadow-flicker simulations in July 2003. The July 2003 model compared the shadow-flicker effects of a 235-foot rotor diameter with a 295-foot rotor diameter, including increased turbine spacing for the larger diameter machines. The analysis looked at landowners located closest to the turbines and in the highest zone of influence as potential receptors of shadow-flicker. The results of shadow-flicker modeling for the “worst-case” receptors are summarized in Table 3.4-2 below. Graphics illustrating shadow-flicker effects for the selected 17 receptors can be found in Appendix B.

Table 3.4-2: Kittitas Valley Wind Power Project Wind Turbine Shadow-Flicker Analysis

Residence	Primary Direction to Turbine(s)	# Hour/Year with Shadow-flicker	# Days/Year with Shadow-flicker	Max # Hours in a Day with Shadow-flicker
Project Configuration with 235-foot Rotor Diameter Turbines				
M. Genson	E/W	93.6	255	1.9
N. Andrew	E/W	84.3	236	1.7
Nelson	E/W	84.1	237	1.4
T Gerean	W	83.0	295	1.1
G. Giesick	E/W	54.9	177	1.4
L. Gerean	W	39.4	171	0.7
Anthony	E	38.1	295	0.8
S. Taylor	S/E	33.4	177	1.0
M. Robertson	E	26.1	208	0.7
Schwab	W	21.5	166	0.5
M Capmbell	W	17.0	178	0.5
Gaskill	E	17.0	137	0.5
Darrow	W	16.7	118	0.4
Burt	W	14.7	139	0.4
Zellmer	W	14.0	179	0.6
Pearson	E	10.5	88	0.4
Price	N	0.0	0	0.0
Project Configuration with 295-foot Rotor Diameter Turbines ¹				
M. Genson	E/W	122.2	252	2.3
N. Andrew	E/W	110.1	233	2.2
T Gerean	W	72.3	134	1.3
Nelson	E/W	70.4	222	1.7
G. Giesick	E/W	48.7	128	1.6
S. Taylor	S/E	32.2	202	2.0
M. Robertson	E	25.6	144	0.8
L. Gerean	W	0.0	0	0.0

Source: Young, pers. comm., 2003.

¹ 295-foot rotor wind turbine casts longer shadow; only residences with more than 48 hours of shadow-flicker were examined

Modeling for the upper end scenario (197-foot meter rotor) was not conducted because it was assumed that modeling the middle and lower end scenarios would adequately evaluate the potential shadow-flicker effects at the site. It is reasonable to assume that although greater in number, the upper end scenario wind turbine generators would exhibit fewer total hours of

shadow-flicker and shorter durations than those seen for the middle scenario because the length of shadow cast from a shorter tower would be smaller.

The model demonstrates that potential receptors (houses) to the north or south of wind turbines are not likely to receive shadow-flicker, because the cast shadow is very short in the north and south directions. Receptors (houses) used in the model represent worst-case scenarios, where the greatest shadow-flicker impacts are expected based on their locations relative to the proposed turbines.

According to modeling results for the middle scenario (235-foot rotors), the highest shadow-flicker level is 93.6 hours per year at receptor M. Genson, while the next highest modeled level is 84.3 hours at receptor N. Andrew. Both receptors would experience shadow-flicker in the morning and evening only if windows are present to the east and west. These receptors also exhibited the highest modeled level of shadow-flicker per day at 1.9 and 1.7 hours, respectively, on days that shadow-flicker is present (Sagebrush Power Partners LLC 2003c). Receptor T. Gerean showed the greatest number of days per year with shadow-flicker at 255.

Shadow-flicker modeling for the lower end scenario (295-foot rotors) showed that M. Genson and N. Andrew also had the highest shadow-flicker (122.2 and 110.1 hours/year) and maximum number of hours per day with shadow-flicker (2.3 and 2.2). These receptors also exhibited the greatest number of days per year with shadow-flicker (252 and 233).

The results of the July 2003 modeling demonstrate that the lower end scenario would result in greater shadow-flicker effects than would occur under the middle scenario. This was expected even though this scenario has fewer towers because the taller towers with the greater diameter rotors would cast longer shadows and have a greater shadow-flicker effect area. It is reasonable to assume that although greater in number, the upper end scenario wind turbine generators would exhibit fewer total hours of shadow-flicker and shorter durations than that seen for the middle scenario.

As stated above, shadow-flicker in residences near the wind turbine generators is not expected to result in health effects. It is, however, anticipated that some residents experiencing shadow-flicker may suffer some annoyance. Suggested measures to mitigate for the effects of shadow-flicker are presented in Section 3.4.4.

Dust Hazards

The project's potential to create dust hazards in the project area was raised as an issue of concern during the EIS scoping period. Dust circulation in open fields such as those found in the project area comes from airflow over loose dust particles on open ground. Wind turbines extract energy from the wind through the aerodynamics of the blades. The rotors would be located between 65 feet (under the upper end scenario) and 115 feet (under the lower end scenario) above ground level and ground level airflow disturbance would be negligible. Furthermore, the wind speed downwind of the rotor is slower than wind speed upwind of the rotor, meaning that dust circulation in the area would possibly even decrease (Sagebrush Power Partners LLC 2003f).

Therefore, the wind turbines would not act as a fan, which accelerates wind across the ground causing additional dust.

Vandalism

The potential for vandalism of project facilities, particularly the effect of gun shots at turbine insulators, was raised as an issue of concern during the EIS scoping period. Wind turbines do not have insulators. According to the Applicant, the towers themselves are sturdy and resilient to vandalism. The project design includes extensive site security measures to ensure that vandalism does not pose a health or safety threat to workers at the project site or residents or visitors in the project vicinity, nor adversely affect project operations. As described in Chapter 2, Section 2.2.5, the plant operations group would prepare a detailed security plan to protect the security of the project and project personnel.

Electric and Magnetic Fields

The potential for the project to create electric and magnetic fields was raised as an issue of concern during the EIS scoping period. Magnetic fields are the result of movement of electrons in a wire (current), and electric fields are created by voltage, the force that drives the electrical current. Electric and magnetic fields (EMF) are produced by any device that consumes or conducts electricity, such as electrical transmission and distribution lines, as well as common household lights and appliances. All of the electrical wiring in homes and office buildings, for example, emits EMF when the power is on, as do televisions, cellular phones, and microwaves, to name a few.

Electric field strength for transmission lines is expressed in units of volts per meter (V/m) or kilovolts per meter (kV/m) measured at a height of 1 meter above the ground. The magnetic field strength is expressed in milligauss (mG) and is also measured at a height of 1 meter above the ground. The strengths of the electric and magnetic fields associated with transmission lines generally decrease as the distance from the conductors increases (Bonneville and EFSEC 2002). Typical electrical and magnetic fields for transmission lines are illustrated in Figure 3.4-2. Computed electric field values at the edge of the transmission corridor right-of-way are fairly representative of what can be expected along the transmission line corridor as a whole. However, the presence of vegetation on or at the edge of the right-of-way can reduce the actual electric field strengths below the calculated values. The height and arrangement of the conductors on the transmission line towers can also affect the field strengths. The presence of other transmission lines can also affect the field strengths, producing higher or lower values (Bonneville and EFSEC 2002).

The average home electric appliance typically has an electric field of less than 0.01 kV/m, while at a distance of 3 to 5 feet, the magnetic field from appliances usually decreases to less than 1 mG (Miller 1975; Gauger 1985).

There are currently no national standards in the United States for electrical or magnetic fields. In the Northwest, Bonneville has established an electric field strength standard of 9 kV/m maximum on the right-of-way and 5 kV/m at the edge of the right-of-way. All Bonneville lines

Figure 3.4-2

are designed and constructed in accordance with the National Electrical Safety Code (NESC). The NESC specifies the minimum allowable distances between transmission lines and the ground or other objects. These requirements help determine the width of the right-of-way. Washington State does not have a regulatory standard for EMF exposure.

Numerous health and safety concerns have been raised in association with EMF from electric transmission and distribution lines. Much of the national and international research regarding EMF and public health risks remains contradictory and inconclusive. As a result, the scientific and medical communities have not been able to form a consistent conclusion as to whether there are any adverse health effects from EMFs at the frequencies typically associated with electric power systems (Walla Walla County 2000).

EMF is considered a possible issue when associated with the siting of high voltage (115kV+) overhead transmission lines close to residences. It is not an issue related to wind turbines, which have low voltage drop-cables (575–690V) contained within steel towers and have a predominantly underground collection system also at a low voltage (34.5 kV) (Sagebrush Power Partners LLC 2003c). However, during project operation, the substations and high-voltage overhead power lines would produce EMF in the immediate vicinity of these facilities.

The high voltage transmission lines associated with the project would be short (i.e., less than 200 feet long) lines that would interconnect the substations to existing overhead Bonneville and PSE transmission lines at the transmission level (230 kV or 287 kV for the Bonneville or PSE lines, respectively). The strength of electric and magnetic fields attenuates rapidly as the distance from the source increases. Typical EMF levels for a 230-kV transmission line show that the electric field would be approximately 0.01 kV/m and the mean magnetic field would be approximately 0.8 mG at a distance of about 300 feet from the EMF source (Bonneville 1995). These EMF levels are comparable to what has been recorded for typical household appliances.

The closest residential receptor to either of the proposed substations is located approximately 4,000 feet away. Most residential receptors in the project area are located more than one mile from the proposed substations. At these distances, EMF generated by proposed facilities would diminish to background levels at nearby residences and would not pose a health or safety risk. Therefore, there would be no EMF exposure to residents in the project area and no impacts would result.

Electrical Shock Hazards

The electrical system at the substations could be susceptible to ground faults, lighting, and switching surges that may result in high voltage, which can constitute a hazard to site personnel and electrical equipment, including protective relaying equipment. The substations would be designed and constructed with systems that would protect project personnel and minimize potential risks associated with accidental exposure to high voltage electrical equipment (see Section 3.4.4).

Decommissioning Impacts

Potential health and safety impacts during the project decommissioning process would be similar to risks identified during project construction. Potential fire risks are similar in nature but less than the risks for project construction. Fire prevention measures during decommissioning would be similar to those used during project construction. The potential release of hazardous materials during decommissioning activities would also be similar to those identified for construction activities.

3.4.3 Impacts of No Action Alternative

Under the No Action Alternative, the project would not be constructed or operated and the existing risk of fire caused by natural sources or human activities not associated with the project would remain. However, development by others, and of a different nature, including residential development, could occur at the project site in accordance with Kittitas County's existing Comprehensive Plan and zoning regulations. Depending on the location, type, and extent of future development at the project site, health and safety impacts could be similar to or even greater than the proposed action. However, the risks associated with tower collapse and detachment or failure of turbine parts would not occur if development other than a wind power project were proposed.

It is assumed that a power-generating facility would need to be built at another location should the KVVPP not be built. This would likely be a gas-fired combustion turbine facility. An example of greater potential for health and safety risks associated with a gas-fired combustion turbine plant is the higher risk of fire or explosion associated with the transmission and use of large quantities of natural gas.

3.4.4 Mitigation Measures

Mitigation Measures Proposed by the Applicant

The Applicant and its subcontractors would comply with all applicable local, state, and federal safety, health, and environmental laws, ordinances, regulations, and standards. Some of the main laws, ordinances, regulations, and standards designed to protect human health and safety that would be reflected in the design, construction, and operation of the project include:

- Occupational Safety And Health Act Of 1970 (29 USC 651, et seq.) and 29 CFR 1910, Occupational Safety and Health Standards;
- Washington Industrial Safety and Health Act (RCW 49.17) and associated rules (WAC 296); Uniform Fire Code;
- Americans with Disabilities Act;
- Uniform Fire Code Standards;
- Uniform Building Code;
- National Fire Protection Association, which provides design standards for the requirements of fire protection systems;

- National Institute for Occupational Safety and Health, which requires that safety equipment carry markings, numbers, or certificates of approval for stated standards;
- American Society of Mechanical Engineers, which provides plant design standards;
- American National Standards Institute, which provides plant design standards;
- National Electric Safety Code;
- American Concrete Institute Standards;
- American Institute of Steel Construction Standards;
- American National Standards Institute;
- American Society for Testing and Materials;
- Institute of Electrical and Electronic and Installation Engineers; and
- National Electric Code.

Fire and Explosion Risk Mitigation Plan (Construction and Operations)

Table 3.4-3 presents the potential causes of fire or explosion during both project construction and operations, and mitigation measures that would be employed to minimize or prevent the risk.

Table 3.4-3: Fire and Explosion Risk Mitigation Plan

C/O ¹	Potential Fire or Explosion Source	Mitigation Measures
C & O	General Fire Protection	<ul style="list-style-type: none"> • All onsite service vehicles fitted with fire extinguishers • Fire station boxes with shovels, water tank sprayers, etc. installed at multiple locations onsite along roadways during summer fire season • Minimum of one water truck with sprayers must be present on each turbine string road with construction activities during fire season
C & O	Dry vegetation in contact with hot exhaust catalytic converters under vehicles	<ul style="list-style-type: none"> • No gasoline-powered vehicles allowed outside of graveled areas • Mainly diesel vehicles (i.e., w/o catalytic converters) used on site • Use of high clearance vehicles on site if used off road
C & O	Smoking	<ul style="list-style-type: none"> • Restricted to designated areas (outdoor gravel covered areas)
C	Explosives used during blasting for excavation work	<ul style="list-style-type: none"> • Only state-licensed explosive specialist contractors are allowed to perform this work; explosives require special detonation equipment with safety lockouts. • Clear vegetation from the general footprint area surrounding the excavation zone to be blasted. • Standby water spray trucks and fire suppression equipment to be present during blasting activities
C & O	Electrical fires	<ul style="list-style-type: none"> • All equipment is designed to meet NEC and NFPA standards. • Graveled areas with no vegetation surrounding substation, fused switch risers on overhead pole line, junction boxes and pad switches • Fire suppressing, rock-filled oil containment trough around substation transformer

Table 3.4-3: Continued

C/O ¹	Potential Fire or Explosion Source	Mitigation Measures
C & O	Lightning	<ul style="list-style-type: none"> • Specially engineered lightning protection and grounding systems at wind turbines and substations • Footprint areas around turbines and substation are graveled with no vegetation
C	Portable Generators – hot exhaust	<ul style="list-style-type: none"> • Generators not allowed to operate on open grass areas • All portable generators to be fitted with spark arresters on exhaust system
C	Torches or field welding onsite	<ul style="list-style-type: none"> • Immediate surrounding area will be wetted with water sprayer. • Fire suppression equipment to be present at location of welder/torch activity
C & O	Electrical arcing	<ul style="list-style-type: none"> • Electrical designs and construction specifications meet or exceed requirements of NEC and NFPA.

Source: Sagebrush Power Partners LLC 2003c.

1 Indicates risk during construction (C) and/or operations (O).

Additional Measures to Reduce Risk of Fire and Explosion during Construction

- The Construction Manager would be responsible for staying abreast of fire conditions in the project area by contacting DNR and implementing necessary fire precautions.
- Fire risk reporting by the Washington DNR would be actively posted at the construction job site during the high-risk season.
- A Fire Protection and Prevention Plan would be developed and implemented, in coordination with the Kittitas County Fire Marshal and other appropriate agencies.
- Potential hazards associated with use of flammable liquids such as construction equipment fuels would be reduced by compliance with a Construction Health and Safety Plan. Each contractor would develop its own plan tailored to suit the specific site conditions, design, and construction requirements for the project. These contractors would administer the program to ensure compliance with laws, ordinances, regulations, and standards pertaining to worker safety, including the State of Washington's construction safety standards (Chapter 296-155 WAC) and the requirements of the Occupational Safety and Health Administration (OSHA) (Title 29, Labor, Code of Federal Regulations Part 1926, Safety and Health Regulations for Construction). The Construction Health and Safety Plan would include the following provisions:
 - Injury and illness prevention plan;
 - Written safety program;
 - Personnel protective devices program;
 - Onsite fire suppression program;
 - Offsite fire suppression support; and
 - Emergency plan.

Additional Measures to Reduce Risk of Fire and Explosion during Operations

- The Applicant has committed to developing and implementing emergency response procedures and employee training addressing the following topics:
 - Personnel injury;

- Construction emergencies;
 - Project evacuation;
 - Fire or explosion;
 - Floods;
 - Extreme weather abnormalities;
 - Earthquakes;
 - Volcanic eruption; and
 - Facility blackout.
- The project O&M group and third party contractors would receive regular emergency response and safety training to ensure that effective and safe action would be taken to reduce and limit the impact of an emergency (including fires and explosions) during project operations.
 - The wind turbine generators would be equipped with specially engineered lightning protection systems that connect the blades, nacelle, and tower to a grounding system at the base of the tower. The blades would be constructed with an internal copper conductor and an additional lightning rod that extends above the wind vane and anemometer at the rear of the nacelle. The Applicant also proposes to keep the areas around each turbine base graveled with no vegetation, to reduce fire risk.
 - The turbine control system would detect overheating in turbine machinery. Internal fires would be detected by these sensors, causing the machine to shut down immediately and to send an alarm signal to the central SCADA system which would notify operators of the alarm by cell phone or pager.
 - The proposed substations would be equipped with specially engineered lightning protection systems to minimize the risk of fire during substation operations. All electrical designs for the substations and interconnection facilities would comply with the National Electric Code and the National Fire Protection Agency regulations and standards. The substations would be completely enclosed by a locked fence and access would be limited to authorized personnel. The area surrounding the substations would be graveled and no combustible vegetation would be located within the fenced area.
 - Permanent meteorological monitoring towers would be installed with a grounding system that protects the meteorological sensors and loggers from electrostatic discharge and provides lightning protection to the tower by bringing the tower and everything mounted on it to ground potential. Lightning dissipaters or rods would be installed at the top of the towers to provide an umbrella of protection for the upper sensors.
 - Only qualified personnel would perform maintenance on the electrical cables. Sufficient clearance would be provided for all types of vehicles traveling under the overhead segments of the electrical lines.

Measures to Reduce Potential Releases of Hazardous Materials to the Environment during Construction

- During construction, the EPC contractor would use fuel trucks for refueling construction vehicles and equipment on site. There would be no fuel storage tanks used at the project site. To avoid spills, fueling trucks would be equipped with auto shutoff valves and other safety devices. The fuel trucks would be properly licensed and would incorporate features in equipment and operation, such as automatic shutoff devices, to prevent accidental spills.

- The oil truck used to fill substation transformers would be properly licensed and would incorporate several special features in equipment and operation, such as automatic shutoff devices, to prevent accidental spills.
- The details of how lubricating oils and other materials would be stored and contained at the construction staging area would be documented in a construction spill prevention and control plan developed and approved by EFSEC prior to commencement of construction. This plan would show storage, detention, and response procedures for all potential chemicals used on site. Implementation of appropriate spill prevention and control measures would ensure that the risk of an accidental release of hazardous materials remains low throughout construction.
- The EPC contractor would be responsible for compliance with applicable federal, state, and local laws, ordinances, regulations, and standards to ensure that the risk of release does not create an adverse health and safety or environmental impact. The EPC contractor would also be responsible for training its personnel in spill prevention and control and, if an incident occurs, would be responsible for containment and cleanup. Spills would be addressed in accordance with the construction spill prevention plan.

Measures to Reduce Potential Releases of Hazardous Materials to the Environment during Operations

- The wind turbines would be equipped with sensors to automatically detect loss in fluid pressure and/or increases in temperature; these sensors would enable the turbines to be shut down in case of a fluid leak. The turbines would be designed with fluid catch basins and containment systems to prevent accidental releases from leaving the nacelle. Any accidental gear oil or other fluid leaks from the wind turbines would be contained inside the towers because they are sealed around the base.
- The pad-mounted transformers would be designed to meet stringent electrical industry standards, including containment tank welding and corrosion protection specifications. These transformers would also be equipped with oil level indicators to detect potential spills.
- The substation transformers would have a specifically designed containment system to ensure that any accidental fluid leak does not result in discharge to the environment. The substation design would incorporate an oil containment system consisting of a perimeter containment trough, large enough to contain the full volume of transformer mineral oil with a margin of safety, surrounding the main substation transformers. The trough and/or membrane would drain into a common collection sump area that would be equipped with a sump pump designed to pump rainwater out of the trough to a nearby natural drainage. To prevent the sump from pumping oil out to the surrounding area, it is fitted with an oil detection shutoff sensor that would shut off the sump when oil is detected. A fail-safe system with redundancy is built into the sump controls because the transformers are also equipped with oil level sensors. If the oil level inside a transformer drops due to a leak in the transformer tank, it would also shut off the sump pump system to prevent it from pumping oil and an alarm would be activated at the substation and into the main wind project control (SCADA) system.
- Waste fluids would be stored in appropriate containers on a concrete surface inside the O&M facility for collection by a licensed collection service for recycling or disposal. The storage area inside the O&M facility would be surrounded by a berm or trough to trap any leaks or spills.

Measures to Minimize Risk of Ice Throw

In order to prevent ice from causing any potential danger, the proposed turbines would be located at least 1,000 feet from any residences. For additional safety, selected turbine rows within 328 feet of public roads would also be equipped with a fail-safe icing sensor system, which would shut the turbines down and activate a local alarm during rare icing events. The affected machine(s) would remain dormant until icing conditions are no longer present.

Measures to Minimize Risk of Tower Collapse and Blade Throw

- The Applicant proposes setbacks of at least the height of the tower plus the blade (overall tip-height) from any public roads and residences. The size of this setback would vary depending on the selected project scenario. The tip-height would range from a low of 260 feet under the upper end scenario to a high of 410 feet under the lower end scenario.
- The wind turbines would meet international engineering design and manufacturing safety standards. This includes tower, blade, and generator design. There is an international quality control assurance program for turbines, and a number of relevant safety and design standards. Quality Assurance/Quality Control (QA/QC) inspections of the wind turbine generators and towers would typically include, but not be limited to, the following operations, checks, and review:
 - Inspection of turbines at manufacturer's facilities;
 - Review and inspection of manufacturer's QA/QC procedures;
 - Manufacturing drawing review and verification;
 - Verification of welding procedure specifications compliance ;
 - Material mill certificates tracking system and verification;
 - Overall visual inspection (including assembly, fastening systems and welding);
 - Inspection of flange interface flatness measurements, finishing and protection;
 - Witness or review of turbine run-in load testing;
 - Inspection of paint finishing and protection;
 - Inspection of painting/marketing/preparation for shipment;
 - Verification of field wiring and tagging; and
 - Pre-Commissioning field testing and verification.
- Foundation design and commissioning checks would address potential equipment failure due to extreme events such as earthquakes or extreme wind loadings, as well as frequency tuning of the different parts of the structure to avoid failure due to dynamic resonance.

Measures to Minimize Exposure to EMF

Proposed high voltage transmission lines would be designed and built according to industry standards to avoid EMF impacts.

Measures to Minimize Electric Shock

The substations would be designed and constructed to have a robust grounding grid that would divert stray surges and faults. Generally, the substation grounding grid would consist of heavy

gauge bare copper conductor buried in a grid fashion and welded to a series of multiple underground grounding rods.

Measures during Decommissioning

An audit would be performed of the relevant operation records and a project site survey would be conducted to determine if a release of hazardous material has occurred. A review of all facilities would be performed to determine if hazardous or dangerous materials (as then defined by regulation) are present as construction materials or materials used in the operation of any facility components such as cleaning and maintenance fluids, lubricating oils, and gases. The project site inspection would determine and record the location, quantity, and status of all identified materials.

Additional Recommended Mitigation Measures

In addition to the mitigation measures proposed by the Applicant above, the following measures would further reduce health and safety related impacts and risks.

Measures to Minimize Risk of Ice Throw

The Applicant proposes to equip selected turbines within 328 feet of public roads with a fail-safe icing sensor system. However, some of the residents in the project area travel on private roads to access their properties. Because some roads appear to be close to the proposed turbines, the Applicant should install a similar icing sensor system on any turbine located within 328 feet of private roads.

Measures to Minimize Risk of Tower Collapse and Blade Throw

The Applicant proposes setbacks of at least the turbine tip-height (ranging from 260 to 410 feet, depending on the project scenario) from public roads and residences as a safety measure to reduce the risk of tower collapse or blade throw. However, some of the residents in the project area travel on private roads to access their properties. Because some roads appear to be close to the proposed turbines, the Applicant should adjust the siting of individual turbines, as necessary, to avoid encroaching upon a 260- to 410-foot setback around private roads.

Measures to Minimize Shadow-Flicker Effects

Shadow-flicker caused from low-angle sun shining through rotating wind turbines would affect several residences in proximity to the project site. Although the number of expected hours of exposure is relatively low, residents may perceive these effects to be significantly disruptive in nature. Recommended mitigation measures to minimize the nuisance effect from shadow-flicker to residents in the project area should include one or more of the following:

- Plant trees between the affected residence and the turbines causing the effect;
- Install fixed shades on affected windows;

- Install automatic shades on affected windows that are opened and closed by electric motor on a timer.

3.4.5 Significant Unavoidable Adverse Impacts

No significant unavoidable adverse impacts on health and safety resulting from the construction, operation, and maintenance of the proposed project have been identified.